EFFECT OF GAMMA AND BETA RADIATION ON METHICILLIN RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) ISOLATED FROM SKIN INFECTIONS

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ABSTRACT

This work evaluated the effect of Gamma and Beta irradiation on Methicillin resistant Staphylococcus aureus isolated from skin infections. S.aureus is an important human bacterial pathogen responsible for a wide variety of conditions, ranging from subclinical inflammation to severe infections such as methicillin-resistant S. aureus (MRSA). Importantly, this colonization is a known risk factor for infection and S. aureus causes a range of infections, from minor skin infections to abscesses and cause of nosocomial infections. The experiment included a control group and 3 irradiated groups by sources (⁹⁰Sr, ²²Na, ¹³⁷Cs) which emitted Beta and Gamma radiation. The effect of Gamma and Beta irradiation on the viability of Methicillin resistant-S. aureus was efficient to killing MRSA S.aureus, percentage of killing increase when exposed time increase from (2- 4) hr. this primary study was to detect the effect of Gamma and Beta irradiation on the viability of S. aureus isolated from skin infections.

KEYWORDS: Staphylococcus aureus, Gamma and Beta irradiation.

INTRODUCTION

Staphylococcus aureus (S. aureus) is a Gram-positive cocci bacterium, aerobic, non Facultative, non sporulating, non motile and divide in several planes forming clumps like grapes, a Yellow-pigmented coccus, which is catalase and coagulase positive, are naturally observed as part of the normal bacteria flora on normal skin and mucous membrane¹¹ that can live as a commensal organism on the skin and in the nose and throat. Approximately 30%
of healthy people are asymptotically colonized by *S. aureus*, which permanently colonizes the anterior nares.\[^{2}\] Importantly, this colonization is a known risk factor for infection\[^{3,4}\] and *S. aureus* causes a range of infections, ranging from (minor skin infections) subclinical inflammation to severe infections causing from to abscesses, pneumonia, endocarditis and septicaemia, emergence of multi-drug-resistant *S. aureus*, such as methicillin-resistant *S. aureus* (MRSA) and vancomycin resistant *S. aureus* (VRSA), has made treatment difficult and increased the rate of mortality. *S. aureus* is also a major cause of nosocomial infections\[^{5,6,7}\] In addition, several cases of community-acquired methicillin-resistant *S. aureus* (CA-MRSA) infections.\[^{8,9,10}\] Notably, severe and even lethal infections by highly virulent strains of *S. aureus* in immunocompetent individuals. *S. aureus* is exposed to a large arsenal of highly efficient antimicrobial host factors during skin colonization and infection. However, a growing number of dedicated resistance mechanisms now contribute to the ability of *S. aureus* to evade host cutaneous defenses and survive during colonization.\[^{11,12}\]

*S. aureus* can cause a wide range of illness from minor skin infections, such as boils, cellulitis, impetigo, folliculitis, carbuncles, furuncles and scalded skin syndrome.\[^{13}\] Methicillin resistant *S. aureus* was first recorded as a nosocomial pathogen in human hospitals and as other *S. aureus* hospital associated isolates have become resistant to most common antimicrobials, and treatment can be difficult.\[^{14}\]

Gamma irradiation is electromagnetic radiation of short wavelength emitted by radioactive isotopes as the unstable nucleus breaks up and decays to reach a stable form. It is widely used for sterilization of medical devices, food preservation and processing of tissue allografts and blood components, obviating the need for high temperatures that can be damaging to such products.\[^{15}\] DNA is the principal cellular target governing loss of viability after exposure to gamma irradiation. DNA damage occurs predominantly by the indirect action of gamma rays, which interact with other atoms or molecules, particularly water, to produce reactive free radicals. Cell death (defined for proliferating cells as loss of reproductive capability) is predominantly induced by double-strand breaks in DNA, separated by not more than a few base pairs, which can generally not be repaired by the cell.\[^{16}\]

Gamma irradiation is a physical means of decontamination, because it kills bacteria by breaking down bacterial DNA, inhibiting bacterial division. Energy of gamma rays passes through hive equipment, disrupting the pathogens that cause contamination.\[^{17}\] Radiation sterilization, as a physical cold process, has been widely used in many developed and
developing countries for the sterilization of health care products. A historical review shows clearly that ionizing radiation was used extensively for the treatment of many types of infections before the advent of antibiotics.\cite{18}

The aim of this primary study was to detect the effect of Gamma and Beta irradiation on the viability of \textit{S. aureus} isolated from skin infections.

**MATERIALS AND METHODS**

**Bacterial isolates**

A total of 100 MRSA isolates were collected from cutaneous samples (abscess and wound) from patients who were admitted to Baghdad hospitals in 2014. These isolates were identified by conventional biochemical reactions according to the criteria established by.\cite{19} The isolates were inoculated a CHROM agar MRSA plate. The results were read after 24 and 48 h of incubation at 35°C.

**Effect of Gamma and Beta Radiation on MRSA isolates**

The irradiation facility used was gamma (\(\gamma\)) and Beta (\(\beta\)) that emitted from \(\text{\(^{90}\)Sr, \(^{22}\)Na, \(^{137}\)Cs}\) isotope exposure time (2, 3 and 4) hr. which are tow sets the 1\textsuperscript{st} with aluminium sheet for \(\gamma\) only and the 2\textsuperscript{nd} without for \(\gamma\) and \(\beta\). The MRSA isolates was grown in LB broth for 24 h. on shaker (150 rpm) at 30ºC. The well grown bacterial culture was centrifuged at 8000 rpm for 15 minutes. The supernatant was decanted and the pellets were suspended in sterile saline. The suspended cells were collected in a clean sterile flask to form pool. The bacterial suspension of the pool (5ml) was distributed in clean sterile screw cap test tubes and exposed to different doses of gamma and Beta radiation, using triplicates for each dose. The non-irradiated control and the irradiated cultures were serially diluted and plated on the surface of TSA agar plates and The colonies were counted and inhibition effect was evaluated and calculated percent reduction of bacterial growth using the following equation described as Trampus \textit{et al.}\cite{15}

\[
\text{Killing of percentage } \% = \frac{\text{Control } – \text{treated}}{\text{Control}} \times 100
\]

The percentage of Killing, calculated from equation
RESULTS AND DISCUSSION
The lethal effect of ionizing radiation on microorganisms, as measured by the loss by cells of colony-forming ability in LB medium, has been the subject of detailed study. Much progress has been made towards identification of the mechanism of inactivation, but there still considerable doubt as to the nature of the critical lesions involved, although it seems certain that lethality is primarily the consequence of genetic damage. Many hypotheses have been proposed and tested regarding the mechanism of cell damage by radiation. Some scientists proposed the mechanism thought ‘radiotoxins’ that are the toxic substances produced in the irradiated cells responsible for lethal effect. Others proposed that radiation was directly damaging the cellular membranes. In addition, radiation effects on enzymes or on energy metabolism were postulated. The effect on the cytoplasmic membrane appears to play an additional role in some circumstances.\[20\]

This study aims to prove the effect of Gamma and Beta irradiation directly on the MRSA S.aureus. After the exposure of S.aureus to different absorbed doses of irradiation by (\(^{90}\)Sr, \(^{22}\)Na, \(^{137}\)Cs) isotope, for different exposure time (2, 3, and 4) hr. the viability of these cells determined using count of S.aureus colony, the results shown in table no. (1).

**Table (1): The inhibition effect of irradiation on S.aureus growth after exposure to Gamma irradiation.**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Type of decay</th>
<th>Gy</th>
<th>Killing ration %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 hr</td>
<td>3 hr</td>
</tr>
<tr>
<td>(^{90})Sr</td>
<td>β</td>
<td>0.415851</td>
<td>0.62483</td>
</tr>
<tr>
<td>(^{22})Na</td>
<td>γ, β</td>
<td>0.0306976</td>
<td>0.04351926</td>
</tr>
<tr>
<td></td>
<td>γ, β</td>
<td>1.3833 *10(^{-7})</td>
<td>1.897324 *10(^{-7})</td>
</tr>
<tr>
<td>(^{137})Cs</td>
<td>γ</td>
<td>0.060085</td>
<td>0.897255</td>
</tr>
<tr>
<td></td>
<td>γ, β</td>
<td>1.105607*10(^{-7})</td>
<td>1.650992*10(^{-7})</td>
</tr>
</tbody>
</table>

Also from table (1) we note that the killing of S. aureus after irradiation with γ and β for different exposure time (2, 3, 4) hr by (\(^{90}\)Sr, \(^{22}\)Na, \(^{137}\)Cs) isotope, increase when the energy of γ and β decrease. The energy of γ emitted by \(^{22}\)Na is 1.275 MeV, the killing ratio is 78.3% while for γ emitted from \(^{137}\)Cs is 0.662 MeV, the ratio was 81.5% so as for γ, β, this is will known that the radiation penetrating will increase with energy. this result give highly precentage of killing of MRSA S.aureus when exposed to Gamma and Beta irradiation, the irradiation effected on cell membrane, DNA, cytoplasmic membrane by absorbance
irradiation and cause damage to this bacteria. Gamma rays cause damage at a cellular level and are penetrating, VG. However, they are less ionising than Alpha or Beta particles, which are less penetrating.[21] therefore by mechanisms of Gamma and Beta irradiation can be elimination of S.aureus that causes many infection to skin of human, particularly S. aureus infections can spread through contact with pus from an infected wound, skin-to-skin contact with an infected person by producing hyaluronidase that destroys tissues and contact with objects such as towels, sheets, clothing, or athletic equipment used by an infected person. Deeply penetrating S. aureus infections can be severe.[22]

REFERENCES


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